Laser Produced Lead/Tin Alloy Plasma for EUV lithogrpahy sources

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Introduction

An investigation of the unresolved transition array around 13.5 nm has been carried out for a lead-tin alloy (composition 40:60) fired at a range of power densities as a possible candidate for a lower melting point liquid target.
Spectra for pure lead and tin were captured under the same experimental conditions to better understand their contribution to the alloy's spectra.

Results

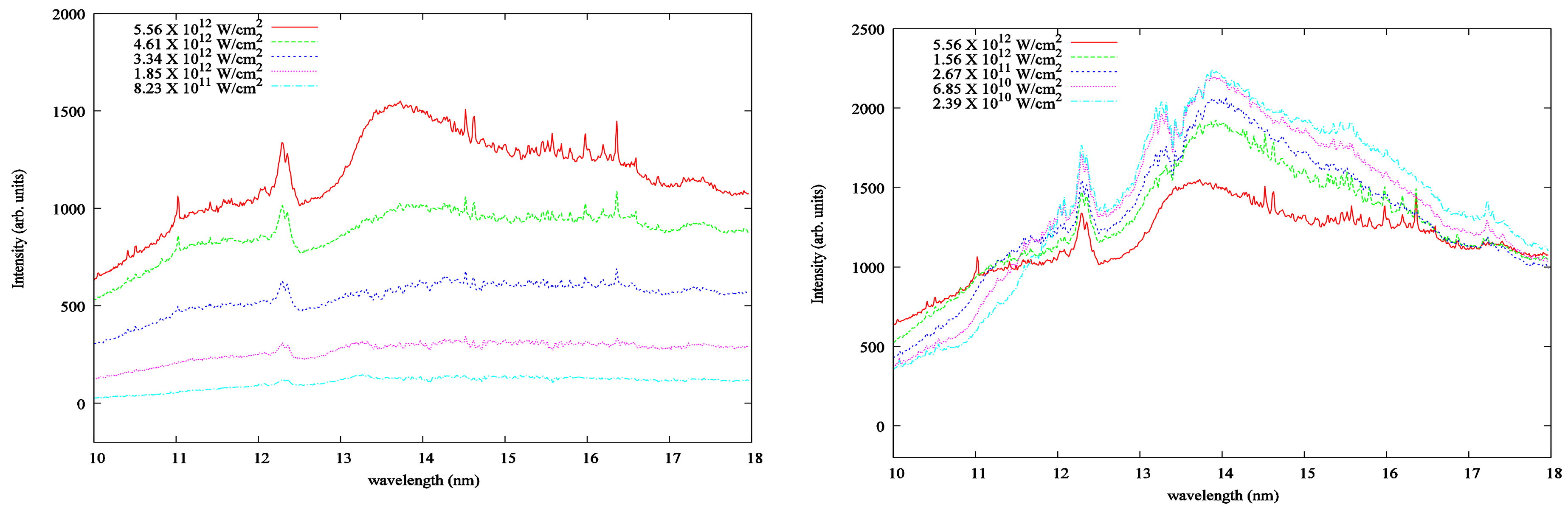

Figure 2: *Shows spectra for the lead-tin alloy for a variety of power densities; a. Shows the spectra obtained for various laser pulse energies, b. Shows the spectra obtained for various lens positions at maximum laser pulse energy.*

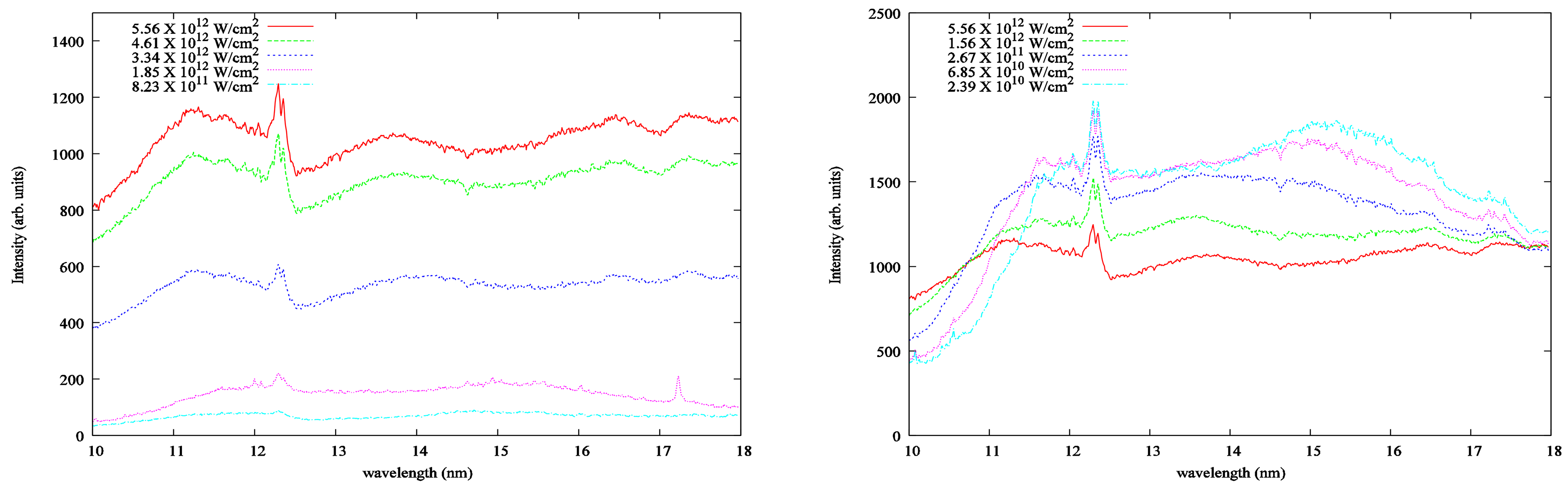

Figure 3: *Shows spectra for pure lead for a variety of power densities; a. Shows the spectra obtained for various laser pulse energies, b. Shows the spectra obtained for various lens positions at maximum laser pulse energy.*

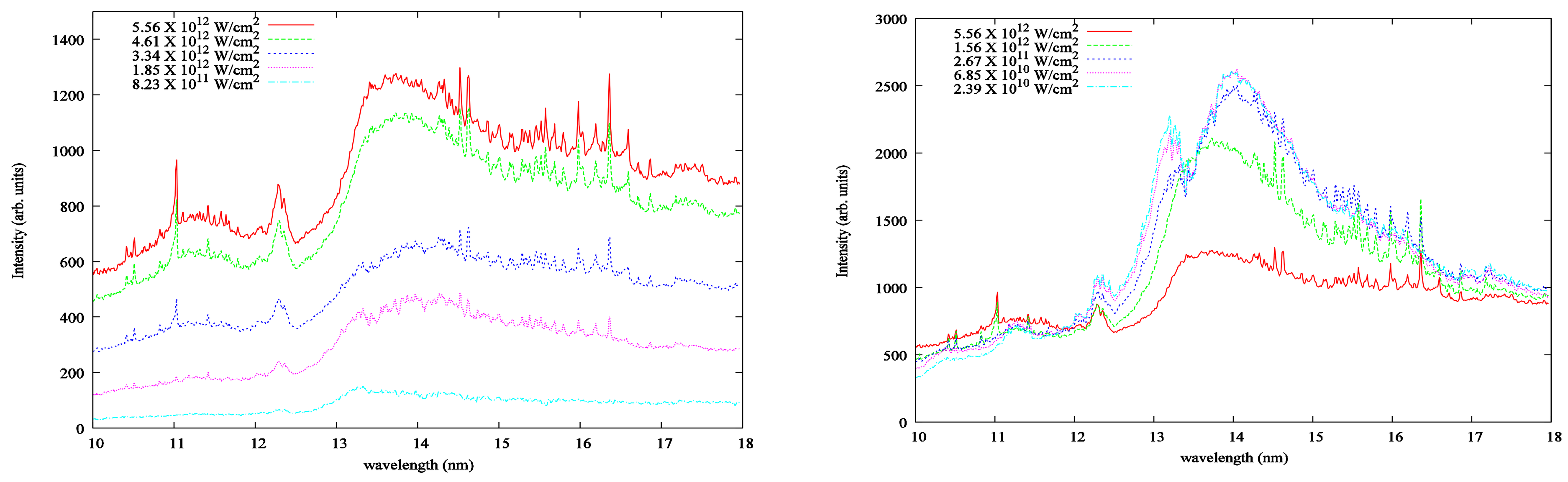

Figure 4: *Shows spectra for pure tin for a variety of power densities; a. Shows the spectra obtained for various laser pulse energies, b. Shows the spectra obtained for various lens positions at maximum laser pulse energy.*

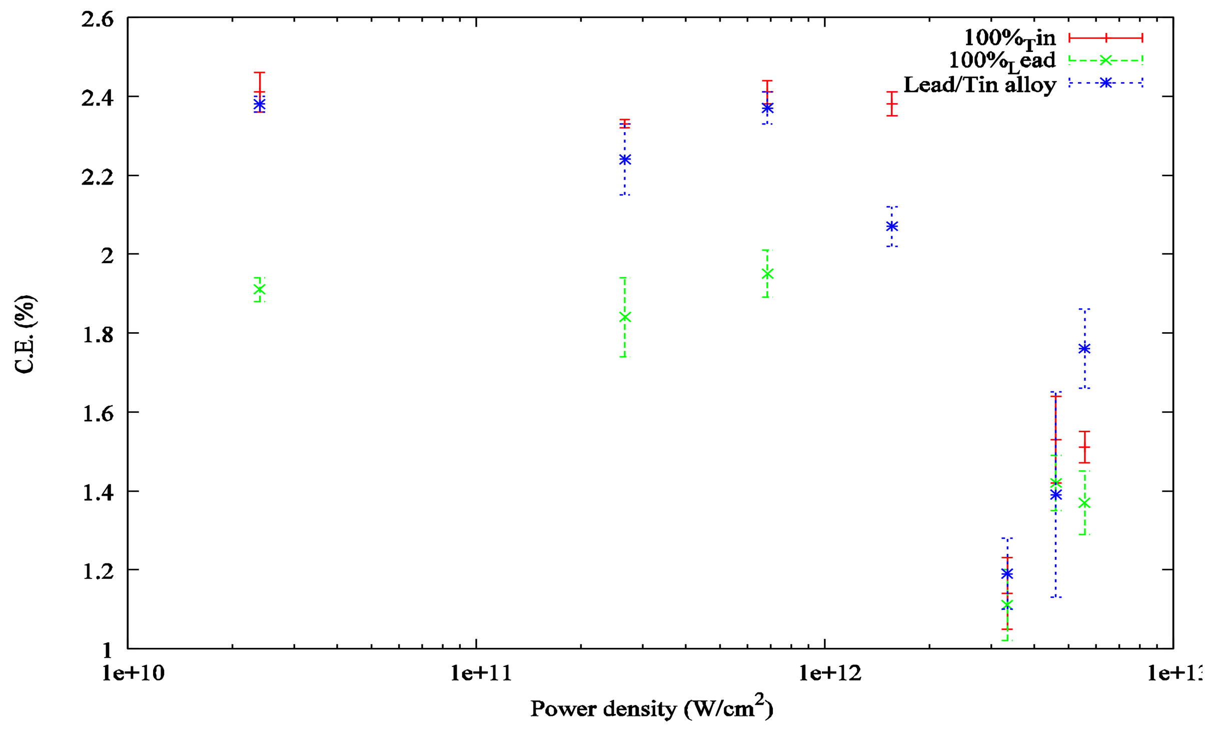

Figure 5: *Shows the conversion efficiencies for pure tin, lead and the lead-tin alloy for a range of power densities.*

Experimental Set up

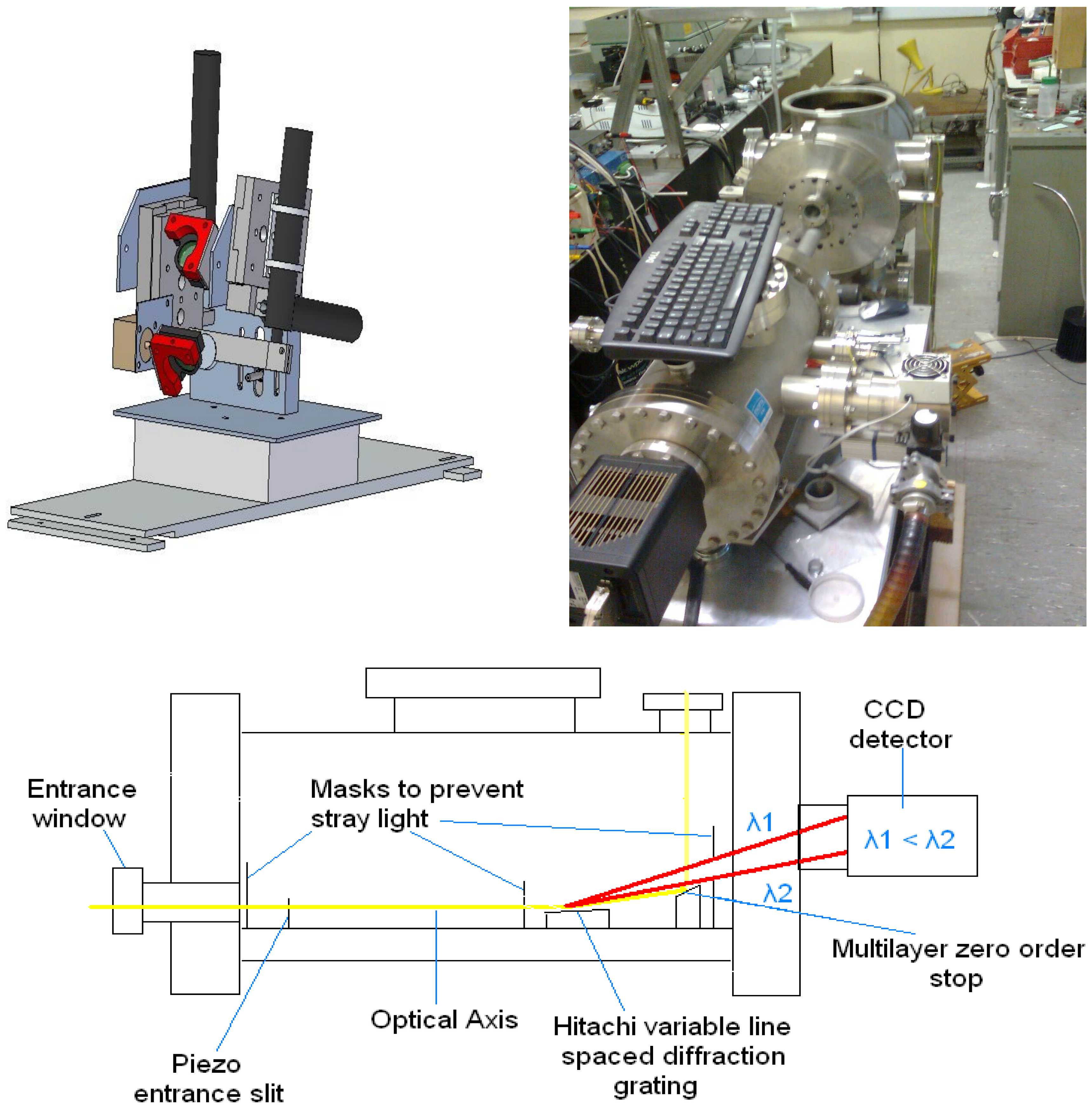

Figure 1: a. *Shows a picture of the rotatable target holder with translational lens position; b. shows a picture of the lab set up; c. Shows a schematics of the Jenoptik Spectrograph*

The laser
A Continuum Surelite_III Nd:YAG laser with a default 10 Hz rep rate. The following parameters describe the laser:
λ = 1064 nm
pulse length = 7ns
The laser was operation in single shot mode.

The Spectrometer
The spectra were captured using an absolute calibrated Jenoptik ¼ m spectrograph with variable line spaced grating. A flat field image on a back illuminated CCD camera. The resolving power at 13.5 m was 1300.

The chamber was pumped to a pressure of 1.6 x 10^{-6} mbar.

The power density was varied by changing the laser Q-switch delay and lens target distance. The lens position when in focus was know with an uncertainty of +/- 1 µm. The lens target distance was varied by an actuator in 1 mm steps.

The target was translated by an actuator after spectra for each power density were obtained, presenting fresh surface to the laser avoiding errors associated with laser drilling. Four shots were carried out for each position, the spectra for the second shot were used in this poster.

The laser was incident at an angle of 10^{o} relative to normal.
The spot radius ranged from 21 µm – 320 µm with power density ranging from $2.39*10^{10}$ W/cm^2 – $5.56*10^{12}$ W/cm^2. Viewing angle was along the target normal.

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